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THE RELATIONSHIP BETWEEN ECONOMIC COMPLEXITY INDEX AND EXPORT: THE CASE OF TURKEY AND CENTRAL ASIAN AND TURKIC REPUBLICS [1]

The paper focuses on the mutual interaction between export from Turkey to Central Asian and Turkic Republics (the CATRs) and exported product range. For measuring the range of exported products, we use economic complexity index (ECI) that refers to the knowledge intensity accumulated in the country's exported products. In addition, ECI provides information regarding the countries' export structures and income levels. We explore how export levels of Turkey and the CATRs, which have common religion and ethnicity, and the countries' ECI scores interact with each other. In this regard, we demonstrate how export affects the countries' ECI for both the CATRs and Turkey. For this purpose, we study the possible relationship between mutual trade volume and the countries' ECI scores by employing Westerlund's cointegration analysis, Pooled Mean Group Estimator (PMGE) model and Dumitrescu-Hurlin's panel causality method. We used the data on the researched countries for the period from 1996 to 2015 collected from official web sites. We have found that export from Turkey to the CATRs and Turkey's ECI scores have a long-term relationship. Additionally, there is a unidirectional causality relationship from Turkey's export to the CATRs to Turkey's ECI score and from the CATRs' ECI scores to the CATRs' export to Turkey. To sum up, our findings support the hypothesis that higher trade volume between Turkey and the CATRs increases the export of complex products for both sides. Based on the results, stronger mutual trade relations increase the total gain not only for Turkey but for the CATRs, too. Lastly, in future studies, we plan to cover all Post-Soviet countries and reveal the relations between bilateral trade and the range of exported products.

Keywords: Economic Complexity Index (ECI), Export, Economic Cooperation, Developing Countries, Central Asian and Turkic Republics, Regional Economics, Post-Soviet Economics, Export Dependent Growth, Free Market, Panel Co-integration, Panel Causality

1. Introduction

Following the dissolution of Union of Soviet Socialist Republics (USSR) in 1991, eight states declared their independencies in Central Asia and Caucasia. Six out of eight countries (Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) are Muslim. The collapse of the USSR accelerated the integration of Eastern Europe, Caucasia, and Central Asia into the global economic system. Moreover, Turkey had intensified economic cooperation with these countries thanks to religious and ethnic roots. Thus, the relations between Turkey and these regions were built on the Muslim-Turk background [1, p. 9–10]. Due of this aspect, Turkey extended both social and economic relationship with Central Asian and Turkic Republics (the CATRs)[2].

In the context of economics, in 2017 the total trade volume between Turkey and the CATRs was 8.3 billion USD, whereas in 1996 it was 1 billion USD. On the other hand, despite improved re-

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[2] Although the official language of Tajikistan is close to Persian, majority of population are sunni Muslim.

Table 1

The General Economic Condition of Turkey and the CATRs (2016)

Countries	GDP (Billion — USD)	Population (Million)	GDP Per Capita (USD)	Average Yearly Growth Rate (Last 5 Years), %	Total Export (Billion-USD)	Total Import (Billion-USD)	Trade Balance	Trade Openness Rate, %
Turkey	863.71	79.5	10.862	5.56	142.5	198.6	–56.1	39
Azerbaijan	37.85	9.76	3.876	1.6	9.1	8.5	0.6	46
Kazakhstan	137.28	17.8	7.713	3.46	36.7	25.1	11.6	45
Kyrgyzstan	6.55	6.08	1.077	4.5	1.4	3.8	–2.4	79
Tajikistan	6.9	8.7	799	6.9	0.9	3	–2.1	56
Turkmenistan	36.18	5.66	6.389	8.86	7.9	4.9	3.0	35
Uzbekistan	67.22	31.85	2.110	7.96	7.4	9.5	–2.1	25

Source: Authors calculations using World Bank and Trade Map data centre.

Table 2

Export and Import Shares of the Most Traded Commodity Groups (HS2) of the Countries (2016)

	Turkey	Azerb.	Kazakh.	Kyrgyz.	Tajik.	Turkmen.	Uzbek.
EXPORT	87 (14 %)	27 (89 %)	27 (61 %)	71 (50 %)	26 (26.5 %)	27 (84.8 %)	71 (39.2 %)
	84 (8.6 %)	08 (2.7 %)	72 (7.5 %)	26 (4.8 %)	76 (23.2 %)	52 (5.9 %)	27 (11.2 %)
	71 (8.5 %)	07 (1.4 %)	28 (6.5 %)	99 (4.8 %)	52 (15.2 %)	89 (2.8 %)	52 (9.7 %)
	61 (6.1 %)	39 (1.1 %)	74 (5.1 %)	07 (4.3 %)	71 (11.1 %)	39 (0.9 %)	74 (6.1 %)
	85 (5.5 %)	76 (1.1 %)	26 (3 %)	87 (3.8 %)	27 (5.7 %)	31 (0.8 %)	08 (5.3 %)
Share in Total Export	42.7 %	95.3 %	83.1 %	67.7 %	81.7 %	95.2 %	71.5 %
IMPORT	84 (13.7 %)	84 (16.5 %)	84 (17.4 %)	27 (10.4 %)	27 (15.7 %)	84 (28.5 %)	84 (18.8 %)
	27 (13.6 %)	73 (10 %)	85 (9.6 %)	84 (10.2 %)	84 (10 %)	73 (12.9 %)	87 (8.9 %)
	85 (10.1 %)	85 (6.8 %)	73 (7.7 %)	64 (6.7 %)	10 (8 %)	85 (11.7 %)	85 (7.5 %)
	87 (8.9 %)	89 (4.5 %)	27 (6 %)	85 (5.4 %)	72 (6.3 %)	87 (4.5 %)	72 (5.5 %)
	72 (6.3 %)	10 (4 %)	87 (4.3 %)	55 (4 %)	87 (5.8 %)	39 (2.6 %)	30 (5.5 %)
Share in Total Import	52.6 %	41.8 %	45 %	36.7 %	45.8 %	60.2 %	46.2 %

Source: Authors' calculation based on Trade Map data.
Note: Related HS2 codes are explained in Table 3.

lations, the share of the CATRs in the total trade volume of Turkey could not reach 5 %. Therefore, analysis of the product qualities contributes to reaching potential trade capacity of both sides. In the research framework, our main motivation is to discover whether the existence of the country trade affects the ECI score of other sides and analyse this impact's direction.

2. Theoretical Overview

2.1. Trade Performance of Countries

Following the end of 70 years of the communist regime, the transition from central state-planned economy to a free market economy was not a painless process. In fact, now there are still low-middle income countries (Kyrgyzstan, Tajikistan, and Uzbekistan) as well as high-middle income countries.[1]

We present the current economic conditions of Turkey and the CATR countries for 2016 in Table 1.

Turkey has an advantage in terms of population and economy in comparison with other countries. Nevertheless, for the last 5 years the average growth rates in Tajikistan, Turkmenistan, and Uzbekistan were higher than in Turkey. In this period (2012–2016) the average growth rate in the world was 2.6 %. All countries in Table 1 (except Azerbaijan) achieved a higher growth rate than the world's average. However, the total share of all aforementioned countries in world export and import is 1.3 % and 1.5 %, respectively. In addition, in terms of trade balance, Turkey, Kyrgyzstan, Tajikistan, and Uzbekistan have trade deficit contrary to Azerbaijan, Kazakhstan, and Turkmenistan. Kazakhstan's trade surplus equals approximately half of the total import value.

The trade openness rates (ratio of total trade to gross domestic product (GDP)) are generally between 35–45 %. However, Uzbekistan's trade openness is lower than general, whereas

[1] World Bank, 2017. https://datahelpdesk.worldbank.org/knowledgebase/articles/906519. (Date of Access: 25.06.2019).

Table 3

Products According to HS2 Codes

HS2 Code	Products
07	Edible vegetables and certain roots and tubers
08	Edible fruit and nuts; peel of citrus fruit or melons
10	Cereals
26	Ores, slag, and ash
27	Mineral fuels, mineral oils, and products of their distillation; bituminous substances; mineral waxes
28	Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes
30	Pharmaceutical products
31	Fertilisers
39	Plastics and articles thereof
52	Cotton
55	Man-made staple fibres
61	Articles of apparel and clothing accessories, knitted or crocheted
64	Footwear, gaiters and the like; parts of such articles
71	Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation, jewellery; coin
72	Iron and steel
73	Articles of iron or steel
74	Copper and articles thereof
76	Aluminium and articles thereof
84	Nuclear reactors, boilers, machinery, and mechanical appliances; parts thereof
85	Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles
87	Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof
89	Ships, boats and floating structures
99	Commodities not elsewhere specified

Kyrgyzstan and Tajikistan have the higher rate (79 % and 56 %, respectively).

Competitiveness in international trade depends on the country's comparative advantage. Therefore, product varieties and most traded products are crucial for detecting the country's trade capacity.

Table 2 demonstrates exported and imported goods of Turkey and the CATR countries under HS2 (Harmonized Commodity Description and Coding System) subject.

The share of top 5 exported products of all countries (except Turkey) is between 68 % and 95 % in total export volume. This ratio is lower for Turkey (42 %). That means that the CATR countries are poorer in terms of product variety than Turkey. On the other hand, the share of top imported products in total import varies between 36 % and 60 %. That fact means that high variety of the imported goods of the CATR countries demonstrates low product variety in export.

For the majority of the CATRs (Azerbaijan, Kazakhstan, Tajikistan, Turkmenistan, and Uzbekistan) HS27 "Mineral Fuels, Mineral Oils, and Products of Their Distillation; Bituminous Substances; Mineral Waxes" is one of the most exported commodities. The top export product in Kyrgyzstan is HS71 "Natural, Cultured Pearls; Precious, Semi-Precious Stones; Precious Metals, Metals Clad with Precious Metal, and Articles Thereof; Imitation Jewellery; Coin"; in Tajikistan it is HS26 "Ores, Slag and Ash". It is easier to classify the countries' import than export. HS84 "Nuclear Reactors, Boilers, Machinery, and Mechanical Appliances; Parts Thereof" commodities are either the first or second item for all studied countries.

The significant sectors of the export products depend on those countries' natural resources. Knowledge and skill level necessary for producing natural resources products are lower than the ones needed for producing the goods from cosmetics or machine sectors.

2.2. Economic Complexity Index (ECI)

Massachusetts Institute of Technology (MIT) developed Economic Complexity Index (*ECI*) to measure the quality of the countries' exported goods according to commodity groups.[1] All products that have the *ECI* score are classified under HS or Standard International Trade Classification (SITC) codes that takes into account the embedded useful knowledge embedded for calculating the ECI[2].

ECI also provides some information regarding the country's income level and possible growth rate for next years [2]. Consumers purchase not only a product but whole knowledge about that product. Thanks to the division of labour, people specialise in the market and gain knowledge via goods [3].

To illustrate, for producing a smartphone it is expected to combine knowledge from different fields, such as electronics, informatics, design, etc.

[1] You can find details regarding ECI calculation: https://atlas.media.mit.edu/en/resources/methodology/. (Date of Access: 25.06.2019).

[2] OEC (The Observatory of Economic Complexity). (2018). Economic Complexity Rankings. Retrieved from https://atlas.media.mit.edu/en/rankings/country/eci/ (Date of access: 13.08.2018).

Table 4

Product Producers According to Production Sectors

Countries	Sector
Germany	Automobile, Pharmaceutical, Cosmetics, Computer
Sweden	Timber, Pharmaceutical, Chocolate
China	Toys, Automobile Spare Parts
Madagascar	Fish

Table 5

Highest and Lowest ECI Scored Products

Code of Product (SITC 4)	Product	Highest ECI Score
7284	Machines and appliances for specialized particular industries	2.27
8744	Instrument and appliances for physical or chemical analysis	2.21
7742	Appliances based on the use of X-rays or radiation	2.16
3345	Lubricating petrol oils and other heavy petrol oils	2.10
7367	Other machine tools for working metal or metal carbide	2.05
		Lowest ECI Score
3330	Crude Oil	–3.00
2876	Tin ores and concentrates	–2.63
2631	Cotton, not carded or combed	–2.63
3345	Cocoa beans	–2.61
7367	Sesame seeds	–2.58

Source: The Atlas of Economic Complexity (https://atlas.media.mit.edu/static/pdf/atlas/AtlasOfEconomicComplexity_Part_I.pdf. (Date of access: 13.08.2018)).

Knowledge capacity of the country has a linear relationship with product diversification. In addition, *ECI* is also interested in the number of countries producing certain products. Table 4 gives information on some countries and relevant production sectors:

According to Table 4, the diversification score of Germany is 4. The ubiquity score of pharmaceutical sector is 2 (Germany and Sweden are the producers). For countries and products, average ubiquity and average diversity are required for calculation. For calculating the *ECI* score, domestic produced and exported goods are taken into account, while domestic consumed products and services are excluded.

We present the highest and lowest *ECI* scored products in Table 5.

Table 5 demonstrates product groups and the *ECI* score for these products. Whereas the most complicated products belong to chemical and machine sectors, which require qualified labour, the lowest *ECI* scored products are raw materials or basic agriculture products. For elevating the *ECI* scores, it is necessary for countries to increase the complexity levels of exported products and competitiveness at the related sectors.

2.3. Literature Review on Trade Relations between Turkey and the CATRs

Turkey recognized the independence of the CATR countries right after the declaration of their independencies. The political, social, and economic relations between Turkey and the region have progressed significantly, especially economic relations based on international trade between the countries. In the literature, there are quite a lot of studies regarding trade relations between Turkey and the CATRs.

Dikkaya [4] studies trade relations in order to monitor the structure and interdependence of trade relations. The works analyse not only commodity trade but also the movements of the Turkey-based capital volumes. Solak [5] focuses on the foreign trade development between Turkey and the CATR countries. The study demonstrates which products are exported to and imported from the Commonwealth of Independent States (CIS) and Turkey. However, this paper can be accepted only as an analysis of the current situation.

Apart from Tajikistan, Alagoz et. al. [6] investigate the relations of Turkey with Asian Turkic Republics. The paper analyses goods and service trade as other studies in the field, and examines economic regulations between Turkey and the CATRs. These regulations include cooperation agreements, mutual promotion of investments, and documents precluding the double taxation. All aforementioned studies state that the countries trade could not react at a sufficient level. Ersungur et. al. [7] discuss trade relations of Turkey and the CATRs preparing distribution of the traded products. At the end of the study, they state that fi-

nancially strong Turkey could assist in raising the CATRs' total trade capacity. Generally, the studies focus on the shares of product groups in the process of mutual international trade. Similarly, Bal et. al. [8] divide traded products into agricultural and industrial, and explain the trade relations by giving descriptive statistics.

The weakness of the Turkish economy in the 1990s could not hamper Russia's economic influence on the region [9]. Nevertheless, Russia's limited economic and military capacity in those years provided an opportunity for the CATRs to act independently [10].

The low trade volume between Turkey and the CATRs also demonstrates that the CATR countries could not adapt to the free market economy. The approach of Gürbüz and Karabulut [11] differs from previous studies. They analyse the degrees of the ex-Soviet countries' similarity in terms of socio-economic conditions. According to the study's results, Latvia and Lithuania are the most similar countries; the Central Asian Republics have some similarities, too. Moreover, these countries' export structure based on natural resources and agricultural production (you can see it in Table 2) confirms the result of the paper.

Sümer and Üner [12] assess psychological distance as a determinant for the trade relations between Turkey and the CATRs. Therefore, trade volume between two countries (Turkey and Azerbaijan), which have the lowest psychological distance, is expected to be high. However, psychological distance theory cannot explain the trade volume between Turkey and Tajikistan.

In addition to such studies, some papers examine competitiveness, technological specialization, and comparative advantage via trade relations [13; 14].

The dependence of the CATRs on natural resources and agricultural raw materials makes their economies vulnerable. The fall of prices of the internationally traded food in the second half of 2014 caused a revenue loss in the CATR countries [15, p. 316]. Additionally, when the CATRs start to ask "How?" instead of "What?" [16], these countries' level of competitiveness in the international trade market can increase. Moreover, as compared with 1990s, the high stability of the Turkish economy positively affects the development of the mutual trade relations.

Contrary to the mentioned papers, we are going to use empirical tests to analyze trade relations between Turkey and the CATRs. Therefore, our study aims to contribute into the current literature by investigating the possible impact of trade on the countries' ECI scores of countries.

3. Econometric Analysis

3.1. Research Model

The study's main goal is to assess the status of trade in the context of *ECI* scores for Turkey and the CATRs. In this respect, we are going to establish how export of both Turkey and the CATRs affects the countries' *ECI*. The study will focus on the results obtained from commercial cooperation between Turkey and the CATRs considering the countries' trade potential and win-win strategy.

3.2. Research Methods and Data

The paper analyses the relationship between mutual export and *ECI* scores of Turkey and the CATRs using panel time-series model in the study's context.

The study's dependent variables are ECI scores of both Turkey (model 1) and the CATRs (model 2). The model's independent variables are export of both Turkey (model 2) and the CATRs (model 1). We derived the data on countries' economic complexity indices from the database of the Observatory of Economic Complexity in the Massachusetts Institute of Technology. We obtained the data on countries' trade from the database of Turkey Statistical Institute. In the study, we used the following variables:

ECI_{tur}: Economic Complexity Index Score of Turkey;

ECI_{catr}: Economic Complexity Index Score of the CATRs;

$\ln(EXP_{tur})$: Export from Turkey to the CATRs;

$\ln(EXP_{catr})$: Export from the CATRs to Turkey.

Depending on this information, we have created the panel time-series model for Turkey and the CATRs to analyse the relationship between the *ECI* score and export;

$$\left(ECItur\right)_{it} = \beta_0 + \beta_1 \ln\left(EXPtur\right)_{it} + \varepsilon_{it}, \quad (1)$$

$$\left(ECIcatr\right)_{it} = \beta_0 + \beta_1 \ln\left(EXPcatr\right)_{it} + \varepsilon_{it}. \quad (2)$$

The study's hypothesis is that increase in the volume of mutual export between Turkey and the CATRs positively influences the economies and enhances the countries' *ECI* scores. We examine the relationships between export and the *ECI* score for both Turkey and the CATRs using the panel and time series analyses. However, firstly, it is necessary to test the stationary variables of the panel time-series.

3.3. Unit Root and Cross-Sectional Dependence Tests

For analysing the co-integration relation between variables in panel time-series, the variables

Table 6

First Generation Panel Unit Root Tests

Variables	Harris-Tzavalis *Z*-Stat.		ADF-Fisher (Maddala ve Wu) x^2-Stat.		PP — Fisher (Choi) x^2-Stat.		Levin, Lin&Chu (LLC) *T*-Stat.		Im, Pesaran &Shin (IPS) *W*-Stat.	
	C	C + T	C	C + T	C	C + T	C	C + T	C	C + T
Series in Level										
ECI_{tur}	−2.280**	−0.478	10.656	3.388	10.725	3.641	−0.394	3.438	−0.494	1.568
ECI_{catr}	−2.943***	−0.035	24.132**	8.298	21.601**	6.058	−2.493***	0.804	−2.015**	1.849
$\ln EXP_{tur}$	14.351	0.286	4.646	13.935	3.044	8.808	−0.896	−1.370*	1.152	−0.460
$\ln EXP_{catr}$	0.123	−2.357***	7.787	20.628	7.548	16.851	−1.863**	−2.243**	0.526	−1.091
Series in First Differences										
ΔECI_{tur}	−15.714	−8.765	65.937	46.516	65.937	46.516	−9.160	−7.965	−7.25	−5.48
ΔECI_{catr}	−17.73	−10.146	40.295	84.065	86.535	103.73	−2.339	−9.137	−3.163	−10.2
$\Delta \ln EXP_{tur}$	−11.59	−5.599	39.899	26.323	39.835	26.612	−4.297	−3.484	−4.205	−2.37
$\Delta \ln EXP_{catr}$	−17.63	−10.01	104.65	84.91	112.98	93.51	−11.541	−10.21	−11.31	−10.18

Notes: "C" stands for constant term, "C + T" represents constant and trend. Lag lengths are chosen according to the T statistics. ***, **, and * indicate significance at 1 %, 5 % and 10 % respectively. All results at first differences are stationary at 1 % significance level.

must be stationary. In this regard, stationary levels of variables should be determined.

Variables in the panel time-series models have been tested using first generation panel unit root tests developed by Harris-Tzavalis [17], Maddala and Wu [18], Choi [19], Levin, Lin and Chu [20], and Im, Pesaran and Shin [21].

As can be seen in Table 6, all of the variables [I(0)] "In level" contain unit root, while the variables [I(1)] "In first difference" are stationary. According to the results obtained by the first generation unit root tests, at their first difference levels [I(1)] variables are stationary. Therefore, it is necessary to test variables by means of the cross-sectional dependence tests. The panel unit root and co-integration tests do not account for the cross-sectional dependence of the contemporaneous error terms. It has been seen in the literature that not considering cross-sectional dependence may cause sizable distortions in panel unit root tests. An analysis that takes into account cross-sectional dependence demonstrates more accurate results. Accordingly, we applied Breusch-Pagan [22] LM test and Pesaran CD-LM [23] tests to panel time-series analysis to test for cross-sectional dependence.

Table 7

Cross-Sectional Dependence Test

Variables	CD Test	Test Statistics	Prob.
ECItur	LM	285	0.000
	CD_{LM}	16.881	0.000
ECIcatr	LM	48.827	0.000
	CD_{LM}	4.808	0.000
lnEXPtur	LM	95.363	0.000
	CD_{LM}	9.171	0.000
lnEXPcatr	LM	39.878	0.000
	CD_{LM}	4.587	0.000

Table 8

Second-Generation Panel Unit Root Test (PESCADF)

Variables	Series in Level		Series in First Differences	
	T-Bar Stat.		*T*-Bar Stat.	
	C	C + T	C	C + T
ECI_{tur}	2.610	1.700	2.610	1.700
ECI_{catr}	−1.945	−1.661	−3.050***	−3.466***
$\ln EXP_{tur}$	−2.286	−1.996	−2.482**	−2.730
$\ln EXP_{catr}$	−3.528***	−2.731	−3.097***	−3.543***

Notes: "C" stands for constant term, "C + T" represents constant and trend. One lag lengths are chosen. ***, **, and * indicate significance at 1 %, 5 % and 10 % respectively.

According to the results in Table 7, the null hypothesis, which refers to cross-sectional independence, is rejected for variables ECI_{tur}, ECI_{catr}, $\ln EXP_{tur}$ and $\ln EXP_{catr}$. Hereunder, both for Equation 1 and 2 cross-sectional dependence in all panel time series are valid. Since the asymptotic properties of the first generation unit root tests affect the cross-sectional section dependence, it is required to test the variables with second generation unit root tests that take into account the correlation of the panel data series. The results of second-generation unit root test are given in Table 8.

The results of the second-generation panel unit root test (PESCADF) in Table 8 demonstrate that variables have unit root [24]. This situation shows that relationship between Turkey and the CATRs as actors in the market are mutually affected. [25, p. 551].

Table 9

Westerlund's (2007) Panel Co-integration Results

	Error Correction Tests	Constant Model		Constant and Trend Model	
		Statistics	Asymptotically *P*-Value	Statistics	Asymptotically *P*-Value
Equation 1	G_τ	–3.431	0.000	–3.800	0.000
	G_α	–14.820	0.000	–17.407	0.021
	P_τ	–8.763	0.000	–8.060	0.000
	P_α	–15.416	0.000	–15.848	0.002
Equation 2	G_τ	–2.156	0.158	–2.268	0.606
	G_α	–9.920	0.110	–10.892	0.645
	P_τ	–4.046	0.334	–3.667	0.961
	P_α	–8.227	0.019	–7.868	0.672

Table 10

Hausman Test for Long-Term Homogeneity

		Coefficients		Differences	Standard Error
		Mean Group Estimator (MGE)	Pooled Mean Group Estimator (PMGE)		
Equation 1	$\ln EXP_{tur}$	0.0864718	0.0810506	–0.0054212	0.0071514
		Chi2 = 0.57			
		Prob > Chi2 = 0.4484			

3.4. Panel Cointegration Analysis

Westerlund's [26] co-integration analysis determines whether there is a long-term relationship between variables. This co-integration analysis provides four panel co-integration tests based on the error correction model for testing the co-integration relationship between panel data. The existence of the co-integration relationship is tested by examining whether each unit has its own error correction [27, p. 239]. Results of Westerlund's panel co-integration analysis of the equations 1 and equations 2 are presented in Table 9.

According to Akaike information criteria, both constant and constant-trend models have a lag length of 0.67 and a lead length of 1 in equation 1. In the case of equation 2, both constant model and constant-trend model have a lag length of 1 and a lead length of 0.5. According to results of Westerlund's panel co-integration analysis, H0 hypothesis has been rejected at 1 % and 5 % significance level in constant and constant-trend models; co-integration relation is determined between panel series in equation 1. In other words, the long-term relationship of the panel series is confirmed. H0 hypothesis has been rejected only at 5 % level for P_α statistic in the constant model in equation 2. According to the G_τ, G_α and P_τ statistics, the H0 hypothesis has not be rejected, thus, there is no co-integration relation among panel series in equation 2. Therefore, variables in equation 2 do not have the long-term relationship.

We assessed the results of the panel co-integration analysis are assessed. We determined that whereas there is a long-term relationship between Turkey's export to CATRs and Turkey's *ECI* score, there is no long-term relationship between the CATRs' export to Turkey and the CATRs' *ECI* score.

3.5. Analysis of Long-Term and Short-Term Relationship

The existence of a cointegration relationship between panel data variables in Equation 1 allows analysing the long- and short-term relationships between these variables. At first, we tested the long-term homogeneity using the Hausman statistic to determine the long- and short-term analysis methods. The Hausman test is performed for establishing the most appropriate method of analysis; the results of the test are given in Table 10.

According to the results in Table 10, the long-term parameters are homogeneous. In other words, the long-term parameters do not change from unit to unit. Therefore, the H0 hypothesis cannot be rejected, meaning that we accept the Pooled Mean Group Estimator (PMGE), which is more effective under the H0 hypothesis, as valid. PMGE analysis method developed by Pesaran, Shin and Smith [28] is based on Mean Group Estimator (MGE), which allows changing both constant and slope parameters in accordance with the units and fixed effect estimator (that permits alternating the constant parameter). In this regard, whereas PMGE keeps the long-term parameters constant, it allows specifying the short-term parameters and error variances in accordance with the units. Table 11 shows the PMGE results for Equation 1.

Table 11

Pooled Mean Group Estimator (PMGE) Results

	Variables	Coefficients	Probability
Equation 1	$\ln EXP_{tur}$	0.081	0.000
	ECT	–0.509	0.000
	$\Delta\ln EXP_{tur}$	0.0381	0.149
	Constant	0.081	0.000

Table 12

PMGE Results (Equation 1)

Units	Variables	Coefficients	Probability
Long Term (*ECT*)	$\ln EXP_{tur}$	0.081	0.000
Azerbaijan	*ECT*	–0.485	0.048
	$\Delta\ln EXP_{tur}$	0.133	0.073
	Constant	–0.672	0.070
Kazakhstan	*ECT*	–0.629	0.006
	$\Delta\ln EXP_{tur}$	–0.045	0.509
	Constant	–0.819	0.019
Kyrgyzstan	*ECT*	–0.591	0.013
	$\Delta\ln EXP_{tur}$	–0.024	0.714
	Constant	–0.698	0.030
Tajikistan	*ECT*	–0.333	0.084
	$\Delta\ln EXP_{tur}$	0.039	0.334
	Constant	–0.385	0.075
Turkmenistan	*ECT*	–0.543	0.035
	$\Delta\ln EXP_{tur}$	0.066	0.337
	Constant	–0.717	0.048
Uzbekistan	*ECT*	–0.479	0.019
	$\Delta\ln EXP_{tur}$	0.059	0.422
	Constant	–0.602	0.043

According to the results presented in Table 11, the error correction term (*ECT*) is rejected at 1 % significance level; here the *ECT* has a negative value (–0.509). Thus, it is proved that there is a long-term relationship between the variables. The ECT demonstrates the existence of deviations in the short-term and the speed of reaching equilibrium in the next period. In this respect, approximately 51 % of the imbalances in any period will be balanced in the next period getting closer to the long-term steady state condition. In addition, the long-term coefficient of Turkey's export to the CATRs ($\ln EXP_{tur}$) is positive (0.081) and significant at 1 % level. However, it was concluded that the short-term parameter ($\Delta\ln EXP_{tur}$) in the model is statistically insignificant. Hence, 1 % increase of export from Turkey to the CATRs provides to ECU 0.081 % increase of Turkey's *ECI* score in the long-term. Results reveal that export from Turkey to the CATRs has a positive relationship with the product diversification of Turkey. Moreover, a possible commercial partnership with the CATRs contributes to the diversity of Turkey's export products.

PMGE also allows analysing the long- and short-term relationships for each unit. In this context, the results of PMGE for each unit are shown in Table 12.

Table 12 shows that the error correction parameter, short-term parameter, and constant parameters are assessed separately for each unit while assessing a single long-term parameter. In this context, we see that error correction parameters of Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan, and Uzbekistan are statistically significant and negative values. Thus, the long-term relationship between Turkey's export to the CATRs and Turkey's *ECI* score are verified. Moreover, the high *ECT* parameters of Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan, and Uzbekistan show that short-term deviations in these countries will be quickly balanced in the long-term. On the other hand, although the *ECT* parameter of Tajikistan is a negative value, it is statistically insignificant. Therefore, there is no long-term relationship between Turkey's export to Tajikistan and Turkey's ECI score.

3.6. Generalized Moments Method and Panel VAR Analysis

The panel VAR model has a dynamic model structure that is used for determining the mutual dynamic relations among the variables. The Generalized Moments Method (GMM) used within the scope of dynamic macro data can yield successful results in the absence of the assumption of externality and in the presence of heteroscedasticity [27, p. 261]. In Table 13, we present the results of panel VAR analysis using GMM.

As seen in Table 13, one lag length of both Turkey's *ECI* score and Turkey's export to the CATRs is positive and statistically significant. One lag length of both Turkey's *ECI* score and Turkey's export to the CATRs have a positive impact (nearly 0.38 % and 0.05 %, respectively) on Turkey's *ECI* score. These results go hand in hand with economic prospects.

3.7. Panel Causality Analysis

Panel causality test developed by Dumitrescu and Hurlin [29] is used to analyse whether there is a causal relationship between the variables. Dumitrescu-Hurlin's panel causality tests hypothesis that does not deny the existence of causality in at least one cross-section against the absence of the homogeneity of Granger causality relationship. In this respect, in the panel causal-

Table 13

Generalized Moments Method Results

	Variables	Coefficients	Probability
Equation 1	ECI_{tur} (1)	0.383	0.000
	$\ln EXP_{tur}$ (1)	0.049	0.000
	Constant	–0.749	0.000
	Wald Chi2(2) = 198.84		
	Prob > Chi2 = 0.000		

Note: "( )" term represents lag length.

Table 14

Dumitrescu-Hurlin's (2012) Panel Causality Tests Results

Causality Relationship	Z^{HNC}, N, T	Z^{HNC}, N
$\ln EXP_{tur} \nrightarrow ECI_{tur}$	3.038***	2.232**
$ECI_{tur} \nrightarrow \ln EXP_{tur}$	1.150	0.731
$\ln EXP_{catr} \nrightarrow ECI_{catr}$	–0.823	–0.838
$ECI_{catr} \nrightarrow \ln EXP_{catr}$	2.688***	1.954**

Note: One lag lengths are chosen. ***, **, and * indicate significance at 1 %, 5 % and 10 % respectively.

ity test Dumitrescu and Hurlin also consider the cross-sectional dependence among the countries. However, Dumitrescu-Hurlin's panel causality tests are not sensitive to the differences between the time-series and cross-section in panel data. In other words, panel causality test provides effective results when the size of time-series and cross-section is larger or smaller than each other [29, p. 1450; 30, p. 125; 31, p. 174–175]. The results of Dumitrescu-Hurlin's panel causality tests are reported in Table 14.

According to the results of the panel causality test, there is a unidirectional causality relationship from Turkey's export to the CATRs to Turkey's *ECI* score and from the CATRs' *ECI* scores to the CATRs' export to Turkey.

Examination of the results of the Dumitrescu-Hurlin's panel causality test demonstrates that the diversity of Turkey's products on the export is caused by export from Turkey to the CATRs. On the other hand, we determined that the CATRs' export to Turkey is caused by the diversity of the CATRs' products on the export. In this respect, we have revealed that product diversity on the CATRs' exported goods has a positive effect on the CATRs' export to Turkey.

4. Conclusion and Discussion

In this paper, we have analysed the influence of international trade of Turkey and the CATRs (that have the common religion or ethnicity) on the countries' *ECI* scores. The paper also investigates the countries' export performance in terms of "neo-factor endowment theory" that provides theoretical framework for technology-based comparative advantage theory. Countries usually implement new technologies or develop new products to enter the foreign markets by specialising their factor endowment basis including knowledge, labour and human capital [32]. Therefore, the study contributes to theoretical literature on international economic relations because the countries' *ECI* score contains the countries' used knowledge and technology endowment for export.

In the study, short-term and long-term relations between exports and *ECI* scores of Turkey and the CATRs are examined by PMGE methods. PMGE methods allow assessing both total and individual exports and the *ECI* scores of the countries. In addition, using GMM methods, we analysed dynamic relationship between variables. Furthermore, we analysed causality relationships among variables with panel causality test. These methodological approaches demonstrate new perspectives for analysing relationships between exports and the *ECI* scores.

Firstly, co-integration analysis is performed in order to demonstrate the long-term relations between Turkey and the CATRs. According to the results of the analysis, there is a long-term relationship between the export of Turkey to the CATRs and Turkey's *ECI* score. The results have demonstrated that 1 % increase in Turkey's export to the CATRs lead to raising 0.08 % of Turkey's *ECI* score. Contrary to such relation, we have not found a long-term relationship between the CATRs' export to Turkey and the CATRs' *ECI* score. Therefore, the export volume of Turkey to the CATRs affects the diversification of Turkey's export products. Thus, we have concluded that intensification of the commercial cooperation between Turkey and the CATRs will positively affect the diversification of Turkey's export products. Accordingly, these results support the hypothesis that increasing Turkey's exports to the CATRs enhances Turkey's *ECI* scores.

As a result of analysing the long-term relationship, we have identified that there is a long-term relationship between the export of Turkey to the CATRs and Turkey's *ECI* score. On the one hand, the high *ECT* parameters of Azerbaijan, Kazakhstan, Kyrgyzstan, Turkmenistan, and Uzbekistan have shown that the short-term deviations in these countries are quickly reaching the long-term balanced level. On the other hand, there is no long-term trade relationship between Tajikistan and Turkey. This situation is acceptable due to the low trade volume between the countries and different ethnic origin compared to other CATRs.

Dynamic relation analysis between Turkey and the CATRs demonstrates that a lag of Turkey's ECI score and one lag of Turkey's export to the CATRs are effective for Turkey's *ECI* score. A lag of Turkey's ECI score contributes approximately 0.38 % to Turkey's *ECI* score. Besides, one lag of Turkey's export to the CATRs contributes nearly 0.05 % on Turkey's *ECI* score. These results are important evidence proving the hypothesis that exports from Turkey to the CATRs enhance Turkey's ECI score.

According to the results of causality analysis, there is unidirectional causality relationship from the export from Turkey to the CATRs to diversity in Turkey's export products. In this regard, increase in the economic cooperation or intensification of the trade relations between Turkey and the CATRs will positively affect the range of Turkey's exported products. Additionally, the diversification of the CATRs' exported products will also increase export of the CATRs to Turkey. As a result of the analysis performed in accordance with the research hypothesis, when diversification of the CATRs' exported products increases, the export from the CATRs to Turkey also follows an increasing trend. Obviously, the activities increasing the CATRs range of exported products range (R&D etc.) ensure a possibility of expanding the Turkey's market for those countries. According to the findings within the study's scope, mutually support for the increase in the volume of foreign trade suggests that "win-win" strategy will work for Turkey and the CATRs. In addition, while increase in Turkey's exports to the CATRs enhances Turkey's *ECI* scores, the difference between our conclusion and the expectations is that increment of the CATRs' exported products raises the exports from the CATRs to Turkey.

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